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ABSTRACT

The issue of whether information to which little or no attention is paid can have lasting effects is of interest to psychologists as well as educators and advertisers. Two experiments were designed to examine whether focused attention is required, whether the immediate memory task is important, or whether subjects' knowledge that repetitions are occurring is essential. Both experiments, with college students as subjects (N=30 and N=30), used a selective listening procedure involving binaural (sounds sent to both ears) presentation of two simultaneous digit series in male and female voices. In the first study, all subjects reported an awareness of the repetitions. In the second study, where only partial recall was required, 25 of the 30 subjects were aware of some repetition. The findings suggest that retention of the temporal order of events appears to require effortful attention. (JAC)

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ATTENTIONAL REQUIREMENTS FOR THE ESTABLISHMENT OF MEMORY FOR SERIAL STRUCTURE

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Attentional Requirements for the Establishment of Memory for Serial Structure

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Paper presented at APA meeting August, 1982

The issue of whether information to which little or no attention is paid can have lasting effects is of interest to psychologists trying to understand the nature of learning, memory, and attention as well as to people with more applied interests such as educators and advertisers. Though there has never been a convincing demonstration of lasting memory for information presented outside of focal attention, it still seems possible that there may be lasting memory for some kinds of unattended information under certain conditions, especially when that information is repeated.

We have been attempting to determine the task and attentional conditions under which repeated presentations of digit sequences will lead to improvements in immediate memory performance.

Previous experiments have consistently shown that when people are presented with sequences of digits in a serial recall task, immediate memory improves with repeated presentations of the same sequence. For example, Hebb (1961) auditorily presented subjects with 24 9-digit sequences, each to be repeated immediately after presentation. One particular sequence was repeated every third trial, for a total of 8 presentations. The result was a gradual improvement in performance on the repeated sequence (see Slide 1). Melton (1963), using visual presentations, demonstrated that the beneficial effect of repetition on recall can be obtained even with repetitions spared as much as 5 (but not 8) trials apart (see Slide 2). Bower and Winzenz (1969) also obtained this effect but showed further that the effect was greatly diminished if the temporal spacing of the digits within a repeated sequence was varied on successive presentations.

Because subjects in these experiments were never instructed that repetitions were occurring, this Hebb effect, or Hebb/Melton effect, has often been taken to mean that little or no attentional effort is required for patterned events to produce lasting traces. However, none of the previous experiments allow us to determine the necessary or sufficient conditions for the Hebb/Melton effect. In particular, it is not clear whether focused attention is required, whether the immediate memory task is important, or whether the subject's knowledge that repetitions are occurring is essential.

The present experiments, which were designed to examine the contributions of these factors, were directly instigated by an informal communication from Larry L. Jacoby, in which he described a preliminary finding (obtained in collaboration with Mark Dallas) of a repetition effect using a procedure in which digit series repetitions were presented outside of focal attention. We sought to replicate this apparent "unattended Hebb effect" as well as to examine the effect of repeated presentations in focal attention under other task conditions.

Experiment 1

Procedure.

In both experiments that I'm going to talk about today we used a selective listening procedure involving binaural presentation of two simultaneous digit series in male and female voices. Half of the subjects atttended to the male voice and half attended to the female voice. The stimuli were constructed from digitized representations of the digits one through nine, equated in duration and loudness, and presented by digital to analog conversion with synchronized onsets at a rate of one per second. No digit was repeated within a 9-digit sequence. The 60 sequences were constructed by a quasi-randomization procedure, rejecting sequences that contained simple ascendng or descending subpatterns as well as ones that matched in more than any three consecutive digits with a previously constructed series and ones that matched in more than two consecutive digits in the same serial positions. The assignment of digit sequences to task conditions was counterbalanced across subjects.

In the first experiment, two immediate recall tasks were used to vary the extent of subjects' attention to the sequential structure of the digit series. The span task required the subject to enter the full 9-digit series on a numerical keyboard immediately after the sequence's presentation (see Slide 3). The target task required the subjects to recall only those digits that were followed by the presentation of the word "target" on a CRT screen in front of them. Two digits from each 9-digit sequence were so designated as targets; one was randomly selected from the first six digits of a sequence and the other from the last three (see Slide 4). Thus, since the subjects only learned whether a given digit was to be remembered after it was presented, they had to attend to each digit. However, in contrast to the span task, the target task did not require attention to the serial order of the digits.

The experiment consisted of 96 trials, of which four were practice trials and two were fillers. Digit sequences were repeated either (a) in the context of the span task, or (b) in the context of the target task, or (c) in the unattended voice. Repeated sequences were repeated five times in the span task and either two or four times in the target task, with two trials between repetitions in both tasks. Because we wanted to maximize the possibility of demonstrating an impact of unattended repetitions, repetitions in the unattended voice always involved either two or four consecutive trials, and the test in the attended voice was always on the trial immediately following the second or fourth presentation in the unattended voice. Tests of the effect of repetition on acquisition of sequential structure were always with the span task. That is, benefits due to repetition were sought as gains in digit-span performance on repeated series relative to performance on novel series. (See Slide 5 for a summary of the sequence of events). Repetition conditions were distributed evenly throughout the total 96 trials in order to avoid bias due to non-specific practice effects.

Thirty undergraduates participated in this experiment to fulfill a course requirement.

Results and Conclusions

The mean pecent correct scores for performance on the span task with different number and type of prior exposures are shown in Figure 1. The major finding was that there was no effect of prior exposures in either the

unattended voice or in the target task (which required attention, but not to sequential structure). Regardless of number of prior repetitions under these conditions, performance on the span task was no better than for sequences that had not been previously encountered. In contrast, repeated presentations with the span task resulted in performance gradually (and significantly) increasing with repeated presentations ($F(4,116) = 22.91$, $MSe = 84.53$, $p<.001$). It appears that repeated exposures of digit sequences result in improved recall only when subjects are attending to sequential structure during the repetitions.

By themselves, these results do not allow us to determine whether the beneficial effect of the span task is due to attention during presentation or to the subject's rehearsal of the sequence during the immedate recall attempt. Accordingly a second study was run in an atempt to obtain a repetition effect using a task that did not require full serial recall.

Experiment 2

Procedure.

The procedure and design of the second experiment were similar to Experiment 1 except for the change in the focal task. A probe recall task which required subjects to recall only two of the digits from a sequence was used instead of the target and span tasks. Immediately after presentation of a digit sequence, subjects were presented with a digit from the sequence which was randomly selected from serial positions two through six. Their task was to recall the two digits that immediately followed this digit in the sequence they just heard (see Slide 6). A different probe position was selected for each repetition.

This experiment consisted of 85 trials which included 12 sequences that were repeated four times each. Thirty undergraduates served as subjects.

Results and Conclusions.

A significant repetition effect was obtained with the probe recall task. As shown in Figure 2, performance on the probe recall task improved as the number of presentations increased ($F(3,87) = 10.14$, $MSe = 113.85$, $p<.001$). This suggests that attention to serial order during presentation is sufficient for the repetition effect. Although rehearsal during repetition of the sequence from immediate memory may also be helpful, it is not necessary.

General Discussion

Post experimental interview responses that we obtained suggested that awareness of repetition may play a role in the Hebb/Melton effect. In a debriefing after our first study, all subjects reported awareness of repetitions. While most were not aware of the frequency and spacing of the repetitions (and tended to underestimate the extent of the repetitions) they reported being aware of fairly regular repetitions.

In our second study, where only partial recall was required, 25 of the 30 subjects were aware of some repetition. Given the similarity of the present experiments to earlier investigations of repetition effects, it seems likely

that many of the subjects in those previous experiments were aware of repetitions and that this awareness is important for obtaining the effect.

Of the earlier studies, only Hebb's included reports of whether subjects were aware of repetition. Hebb found that 25 of his 40 subjects were aware. Also, when subjects were informed of the repetitions late in the experiment, performance improved sharply.

Our results have implications for theories that contrast effortful vs. automatic processes. The findings suggest that the proposal offered by some theorists (e.g., Hasher & Zachs, 1979), that the time of events is automatically encoded, will require at least some qualification. Retention of the temporal order of events does appear to require effortful attention, at least under the circumstances that obtained in our experiments.

We undetook to study the Hebb/Melton effect because of an interest in a broader problem -- the effects of involuntary exposures to information. We live in a world in which people are exposed to many communications that they haven't chosen to see or hear. We might be justifiably concerned if such involuntary exposures inevitably left lasting imprints, because it would then be possible for those with control of the media to educate, persuade, and propagandize us as they pleased. Indeed, many people are concerned about the possibility of being influenced to purchase products by pictures that are briefly flashed during television shows or by subaudible messages that are embedded in department store Muzak.

In regard to such possibilities, we found no evidence that messages in the form of digit sequences left traces that preserved serial order information -- unless subjects were given a task that obliged them to attend effortfully to, and to try to remember, the serial order. This finding provides at least limited reassurance to those concened about the possibillities of covert propaganda. The result is perhaps less welcome to students trying to prepare for examinations by playing taped lectures as they watch football games on television.

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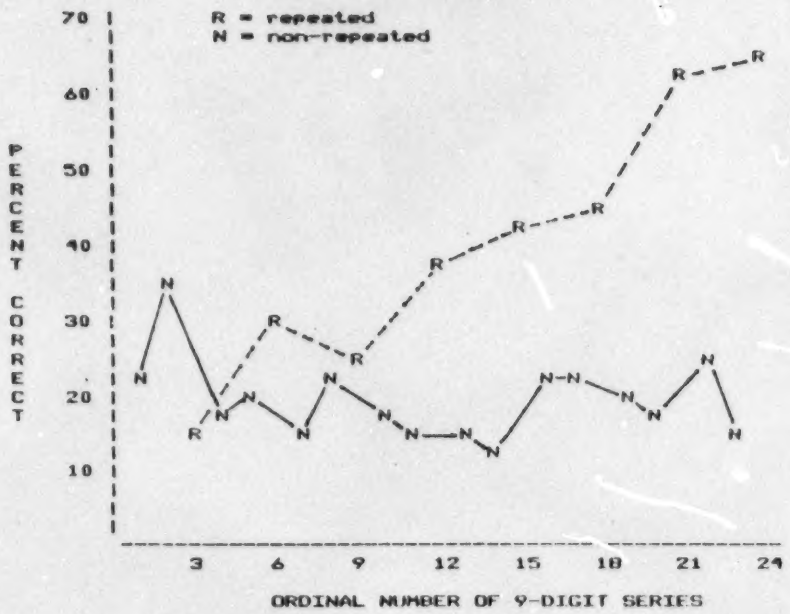
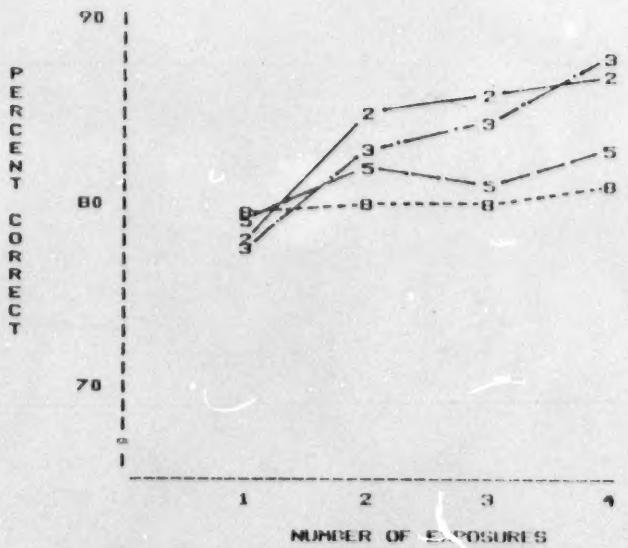
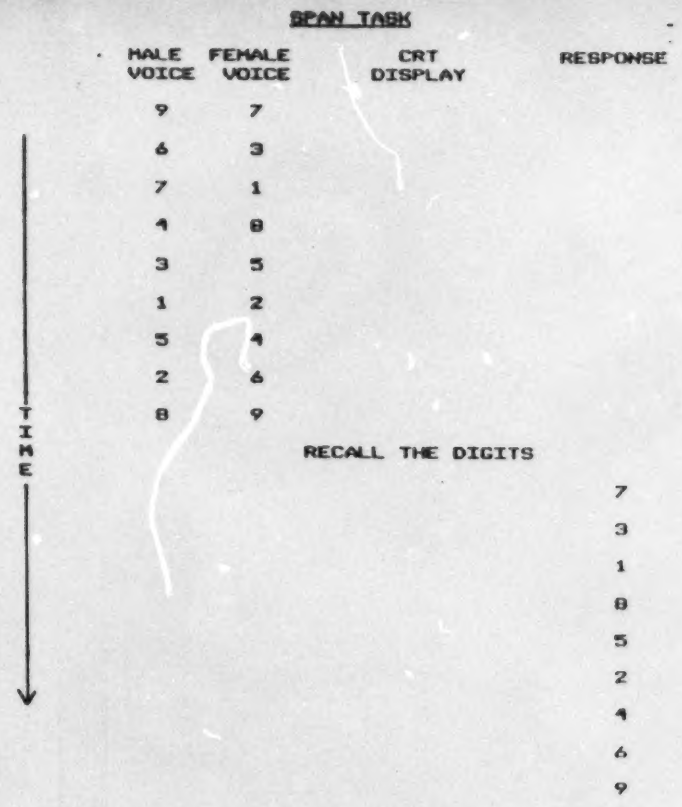


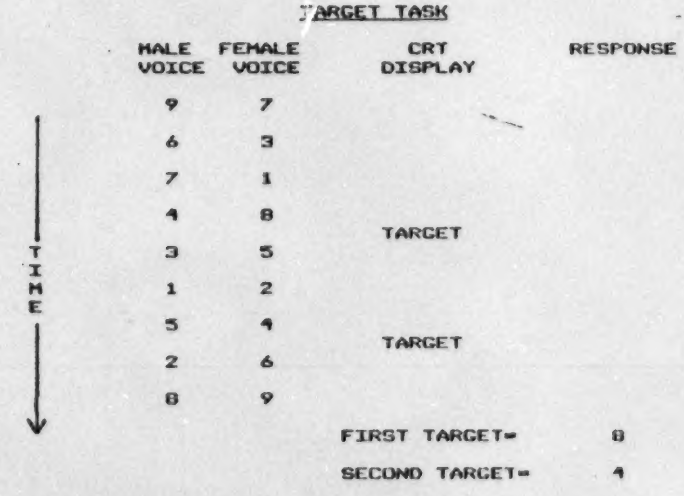
Slide 1. PERCENTAGE OF COMPLETELY CORRECT RECALL ON A SPAN TASK FOR REPEATED AND NON-REPEATED DIGIT SERIES. N=40. (FROM HEBB, 1961).



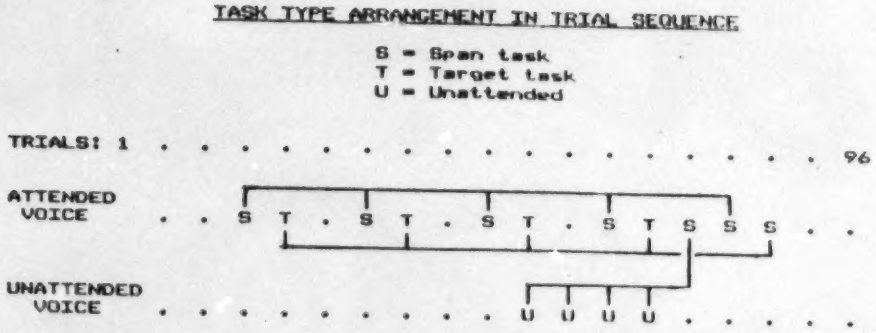
Slide 2. MEAN PERCENT CORRECT SCORES AS A FUNCTION OF NUMBER OF EXPOSURES AND NUMBER OF INTERVENING SEQUENCES BETWEEN REPETITIONS. N=32. (FROM MELTON, 1963).



Slide 3. SEQUENCE OF EVENTS FOR THE SPAN TASK. FEMALE VOICE IS ATTENDED



Slide 4. SEQUENCE OF EVENTS FOR THE TARGET TASK. FEMALE VOICE IS ATTENDED



Slide 5. Repetitions of a given sequence are connected by a solid line. The letters indicate the task type for each presentation.

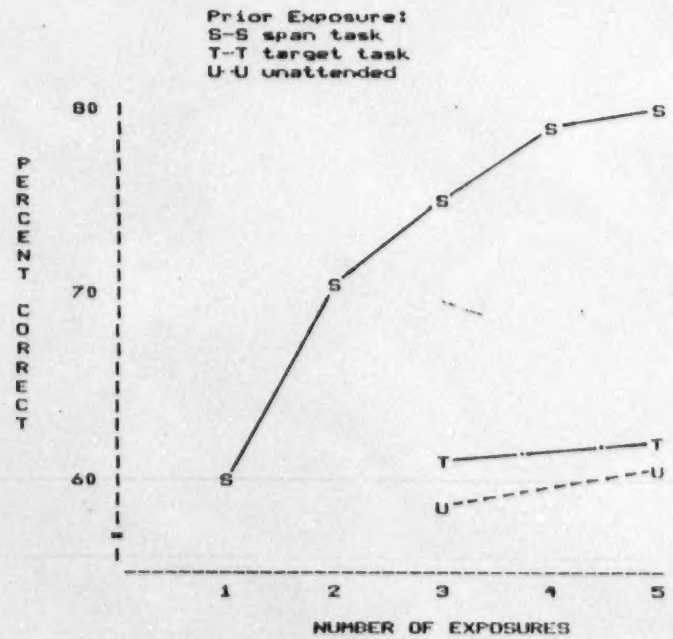
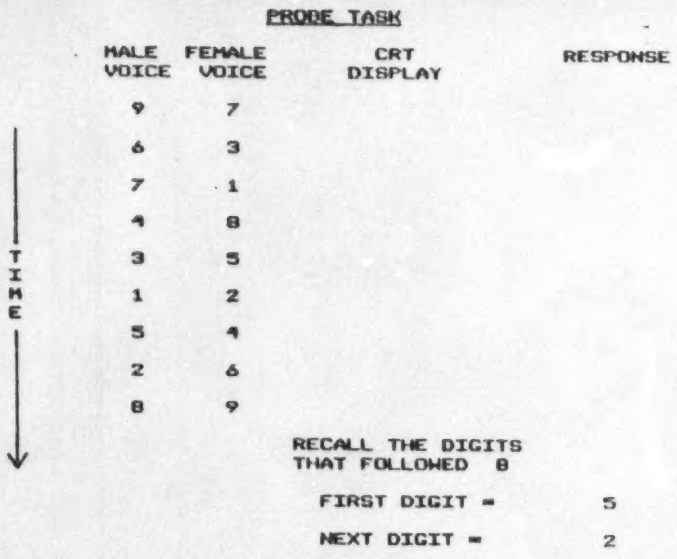


FIGURE 1. MEAN PERCENT CORRECT SCORES FOR PERFORMANCE ON THE SPAN TASK WITH DIFFERENT NUMBER AND TYPE OF PRIOR EXPOSURES. N=30.



Slide 6. SEQUENCE OF EVENTS FOR THE PROBE TASK. FEMALE VOICE IS ATTENDED

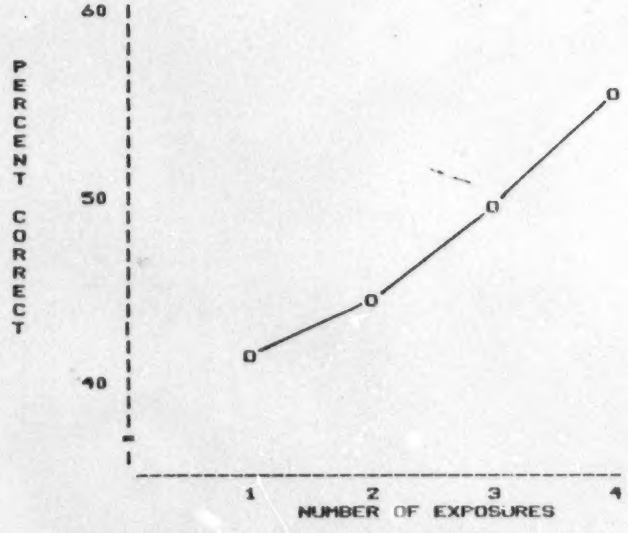


FIGURE 2. MEAN PERCENT CORRECT SCORES FOR PERFORMANCE ON A PARTIAL RECALL TASK REQUIRING ATTENTION TO SEQUENCE. N=30.